PURE EARTH

BLACKSMITH INSTITUTE

Global Lead Program

Tools, Technologies And Projects To Remediate Lead Pollution And Reduce Public Health Risks

About Pure Earth

Pure Earth is a US-based, non-profit organization dedicated to reducing public health risks from toxic pollution in low- and middle-income countries. Since 1999, Pure Earth has conducted more than 90 projects around the world to remediate contaminated sites and reduce public exposures to chemicals and heavy metals. Many of Pure Earth's projects are designed to identify, assess and reduce public and occupational exposures to lead (Pb) contamination. Pure Earth has conducted more than 1,000 field assessments of sites contaminated with lead.

Lead (Pb) Remediation Tools And Technologies

Rapid Environmental And Health Risk Assessments

Over the last 17 years, Pure Earth has conducted more than 3,000 rapid site assessments at contaminated sites around the world through its Toxic Sites Identification Program. Of these sites, 1,183 were contaminated with lead. Pure Earth has developed a unique rapid site assessment protocol developed in collaboration with experts from the U.S. Environmental Protection Agency, the World Bank, Mt. Sinai School of Medicine, Harvard University and others.[i]

At sites where heavy metal contamination is suspected, Pure Earth measures metal concentrations in soil using a portable, hand-held X-ray florescent (XRF) analyzer to collect geospatial data on contaminant concentrations. Conducting in-situ soil screening using a hand-held XRF analyzer has been shown to be an accurate and extremely effective tool for site characterization.[ii] Pure Earth's rapid assessment protocol allows site assessors to quickly characterize lead contamination and related health risks in order to evaluate the need for remediation or other risk-reduction activities and prioritize responses.

Site Prioritization And Project Selection

Pure Earth has developed a global contaminated site database that uses an algorithm to analyze data collected during site assessments and evaluate the potential public health risks. The database generates a relative risk score from 0-10 for each site. The database's algorithm utilizes contaminant concentration data, toxicity data, information about populations living and working around the site, and a variety of other environmental and social data to generate the relative risk score. Pure Earth's database can be used to compare risks between sites and help governments prioritize their efforts to address sites that pose the greatest risk to human health and the environment first.

Detailed Environmental And Health Risk Assessments

Pure Earth's technical experts conduct detailed assessments of sites that are being considered, or have been selected for remediation. Detailed assessments include extensive soil screening using an XRF analyzer to more fully characterize the extent and severity of lead contamination both laterally and vertically. Duplicate samples are analyzed for total lead at a certified lab to ensure accuracy of the XRF readings. If water supply wells or other water bodies are present, Pure Earth typically collects and analyzes representative water samples to evaluate potential impacts to drinking water supplies or surface water bodies as warranted. Detailed assessments also include interviews with community members, health professionals and local leaders.

Conceptual Site Modeling

Once Pure Earth completes a detailed assessment, technical experts create a conceptual site model to visually display the relationship between the source of contamination, the pollution's migration route through the community, and the exposure pathway into the bodies of local residents (ingestion, inhalation or dermal contact). The conceptual site model is used to design the most effective remediation and risk-reduction strategies.

Alternatives Analysis

Once Pure Earth has conducted a detailed site assessment and designed a conceptual site model, the organization designs several alternative remediation strategies and analyzes the options to show the costs and benefits of each strategy. This allows governments, donors, community members and other stakeholders to understand how and why a final remediation strategy is selected.

Remediation Methods

In-Situ Soil Capping
For some chemical contaminants, new technologies allow for improved remediation strategies and results. However, for lead, capping contaminated soil with other clean materials is often the most appropriate risk-reduction method, and has been the preferred method of remediation at most lead sites encountered by Pure Earth. Soil capping is typically a cost-effective strategy to significantly mitigate exposure to lead impacted soil and reduce health risks. In most cases, capping can be implemented using locally available materials and labor. The effectiveness of soil capping has been demonstrated through projects implemented around the world and has been validated through a number of studies.[iii]

Pure Earth's lead capping activities typically begin with the application of a water-permeable geotextile fabric or liner over the lead-impacted soil to act primarily as a marker layer to alert residents of contaminated soil below when digging, or to

indicate the need for additional capping material if erosion exposes the marker layer. Clean soil (approximately 20 cm), concrete or other material is then applied on top of the geotextile layer. The selection of the most appropriate capping material is based on surface grades, site usage and cost. Clean topsoil is typically seeded to minimize erosion.

Excavation And Disposal
Pure Earth excavates contaminated soil and disposes of it in appropriately permitted landfills (a method sometimes called “dig and dump”) only when the contaminated site is likely to be excavated or disturbed in the future (for example, because of anticipated building construction). If no appropriately permitted waste landfill is available, Pure Earth may construct a specially designed containment facility at or near the contaminated site with government approval (see the project description from Cinangka, Indonesia below).

Recapture And Re-Smelting
In cases where the lead concentration in soil is above a certain percentage (e.g., soil with more than 2% lead content), it may be possible to recapture the lead, smelt it, and enter it back into the formal industrial supply chain. The concentration of lead that makes recapture cost-effective is site specific and depends on local market forces and on the technology used to capture and smelt the lead.

Mitigating Pollution From Active Sources
Pure Earth has extensive experience working with informal recycling communities and small and medium sized enterprises to reduce active emissions and protect workers and local residents. Pure Earth’s technical experts have implemented pollution reduction programs with e-waste recyclers, battery recyclers, smelters, miners and a variety of other industrial sectors.

Partnerships, Funders And Recent Projects

Partnerships

In each of its projects, Pure Earth works in collaboration with municipal, provincial or national governments. Pure Earth does not conduct projects without the approval and collaboration of a relevant government authority. Pure Earth also works in close collaboration with a variety of international organizations and universities, including the World Bank, United Nations agencies (UNEP, UNDP and UNIDO), the International Lead Association, the Secretariats and Regional Centers for the Basil, Rotterdam, Stockholm and Minamata Conventions, Mt. Sinai School of Medicine, and many others.

In additional to the partnerships above, Pure Earth is the Secretariat of the Global Alliance on Health and Pollution (GAHP). The members of GAHP include ministries of health and environment from 23 countries, as well as 27 international agencies, universities and civil society groups. More information is available at www.gahp.net.

Funders

Pure Earth's work is funded through grants, contracts and donations from organizations including: the World Bank, the Asian Development Bank, the European Union, USAID and other bi-lateral agencies, foundations and individuals. A complete list is available in Pure Earth's Annual Report.

Recent Projects

Kabwe, Zambia
In May of 2017, the cover story of the newspaper *The Guardian* labeled the city of Kabwe, Zambia, "The World's Most Toxic Town." Kabwe is the second largest city in Zambia, with a population of more than 200,000 people. For more than 90 years, lead mining and smelting in Kabwe created extraordinary pollution in both industrial and residential areas. Today, concentrations of lead remain high and pose severe health risks to local children.

In 2014, Pure Earth conducted a comprehensive environmental assessment in Kabwe to understand where the lead hotspots were located within the community and to identify relevant exposure pathways. Based on that assessment, Pure Earth developed a plan to conduct targeted cleanup and risk-reduction activities, including blood-lead level testing and remediation of high-risk areas, starting with the most severely contaminated neighborhoods.

Since then, Pure Earth and its local partners have remediated 128 residential yards contaminated with lead in Kabwe. This project consisted of capping residential soils and public areas, cleaning the interiors of homes, a robust public education and awareness campaign, and project monitoring and evaluation activities. The purpose of these activities was to reduce blood-lead concentrations of local residents and train community members and government employees to replicate and implementing this type of project in the future.

Additional information about the project is available here.

Dong Mai, Vietnam
Dong Mai Village, Vietnam, was the site of a severe lead poisoning epidemic caused by contamination from decades of recycling of used lead-acid batteries. In 2008, an industrial area was constructed 1 km south of Dong Mai, and most recycling activities were relocated from residential areas to the industrial estate.

However, because lead is very immobile in the environment, surface lead levels in residential areas of central Dong Mai remained dangerously elevated from past recycling activities. In 2013 and 2014, Pure Earth and its partners capped contaminated soil at 39 residential properties and public spaces.

After the remediation activities were complete, Pure Earth conducted environmental sampling in all of the remediated yards and found lead levels at or below 50 ppm in all yards (8x below the U.S. EPA standard for residential soil). In addition to environmental sampling, blood-lead levels were collected and analyzed from a total of 263 children before and after the project. Blood-lead levels in children age 0-5 decreased by an average of 72%, from a geometric mean of 39 µg/dL to 11 µg/dL.

Additional information about the project is available here.

Cinangka, Indonesia
The village of Cinangka is a dense residential area with a history of lead contamination from numerous small-scale used lead-acid battery recycling facilities. In addition to these active operations, there are waste dumpsites in central community areas throughout the village. Prior to the involvement of Pure Earth, lead waste from former smelting activities in the Cinangka area was collected and disposed of in shallow burials and surface dumps around the village soccer field and the adjacent ravine.

Between 2013 and 2014, Pure Earth managed a project to excavate 2,850 cubic meters of soil contaminated with lead. Pure Earth and its partners constructed a new hazardous waste containment facility under an existing football field in the town. The excavated waste material was disposed of in the facility and covered with a liner, limestone and clean soil.

Additional information about the project is available here.

Additional Projects
Pure Earth has conducted additional lead remediation and risk-reduction projects in the following communities:
Zamfara, Nigeria
Rudnaya Pristan, Russia
Haina, Dominican Republic
Morelos, Mexico
Sovetskoe, Kyrgyzstan

[i] Ericson, B., Caravanos, J., Chatham-Stephens, K., Landrigan, P., & Fuller, R. (2012). Approaches to systematic assessment of environmental exposures posed at hazardous waste sites in the developing world: the Toxic Sites Identification Program. Environmental Monitoring and Assessment, 185(2), 1755-1766. doi:10.1007/s10661-012-2665-2

[ii] Rouillon, M., Taylor, M. P., & Dong, C. (2017). Reducing risk and increasing confidence of decision making at a lower cost: In-situ pXRF assessment of metal-contaminated sites. Environmental Pollution. doi:10.1016/j.envpol.2017.06.020

[iii] Laidlaw, M. A., Filippelli, G. M., Brown, S., Paz-Ferreiro, J., Reichman, S. M., Netherway, P., . . . Mielke, H. W. (2017). Case studies and evidence-based approaches to addressing urban soil lead contamination. Applied Geochemistry, 83, 14-30. doi:10.1016/j.apgeochem.2017.02.015